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Barkbeetle Epidemics and Rainfall Deficiency.

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The periodicity of barkbeetle epidemics is one of the most interesting phenomena connected with their occurrence. For some years the history of such outbreaks has been recorded by Dr. Hopkins and other entomologists of the Division of Forest Insects. Striking examples of these epidemics such as that in the Black Hills from 1900-05; the West Virginia outbreak of 1891-92, and many more have been studied. Epidemics of the Black Hills beetle and the southern pine beetle are characterized by short periods of intense activity; that of the western pine beetle of more continuous aggressiveness annually killing low percentages of timber which in some years increases to one or two per cent of the stand.

Many reasons have been advanced to explain such outbreaks, namely preceding forest fires; large quantities of slash; windfallen timber; lightning storms, and climatic conditions. Careful consideration of all the data obtainable, especially the more recent studies of Messrs. Miller, Keen, Patterson and the writer, on the bionomics of these beetles more and more suggest that the underlying causes are within the tree itself - certain as yet unexplained conditions of the tree making it more susceptible to attack or favorable for successful development of the barkbeetle broods. If such is the case climatic conditions would be the only factors so directly reaching on the tree.

Drought periods have frequently been suggested as the most important single factor. Such suggestions have again and again come from experienced

woodsmen, foresters, and entomologists. An article by Clements[1]

1. Drought Periods and Climatic Cycles, Ecology, Vol. 2, No.3, 1921.

~~suggested the~~ indicates a certain coincidence of drought periods and western b.b. epidemics ~~climatic cycles~~ and promoted the following tabulation of precipitation and barkbeetle outbreaks for the east. These are a number of published statements, calling attention to this association - Felt, Blackman the expanded

No attempt has been made to carefully compare temperature conditions with these outbreaks for the following reasons. These beetles work concealed beneath the bark, an excellent insulating material, and could hardly be subjected to temperature variations. The same species occur over wide ranges of territory subject to such an extreme temperature variation as that of southern Mississippi and the high mountains of West Virginia, from a nearly frostless winter to 10° or more below zero. The sudden disappearance of these outbreaks due to the destruction of the broods has in nearly all cases taken place during the summer or early fall. It is consequently felt that temperature cannot be a very important factor.

The Southern Pine Beetle Outbreak and Precipitation.

In the following discussion an attempt is made to bring together all available records of southern pine beetle outbreaks, to give something of the history of these, and to compare them with the rainfall records of the nearest Weather Bureau station.

Authentic records of outbreaks of the southern pine beetle date from 1890 when the widespread West Virginia epidemic attracted Dr. Hopkins' attention. Since then the periodic appearance of this insect has been recorded in the files and notes of the Bureau of Entomology by Dr. Hopkins and his assistants. Most of these records are based on examination of the dying timber made by representatives of the Bureau though some cases are based on specimens of the beetles or their work submitted by correspondents.

Since the first evidence of outbreaks is obtained through reports of correspondents noticing the dying timber in the field, our records cannot be expected to be anywhere near complete, for it is only when the evidence is widespread or particularly noticeable locally that it attracts sufficient attention to be reported. It likewise rarely happens that the first dying of the pines is called to our notice. Many local outbreaks will, therefore, be missed and for this reason it is not possible to attempt to correlate all drought periods in the Southwest with barkbeetle epidemics.

In the following discussion only those records of outbreaks in the Bureau files are given, where one of the officers visited the location and the cause of the dying trees was authentically determined as Dendroctonus frontalis Zimm.

Review of Evidence Presented.

It is certainly at least very suggestive from the following records that there is an intimate relation between outbreaks of the southern pine beetle and rainfall deficiencies. Every authentic record, with the two exceptions noted (Ashland and Accomac, Va.) have occurred over two to four years-periods during which the rainfall was below the mean.

The fact that these epidemics start on southern exposure, or high ridges, or poorer sites, lends further support to this theory; as well as the fact that in no case have these outbreaks died out until an excess of percipitation is recorded.

Late summer and fall deficiencies seem to be more important in starting epidemics than those at other seasons, and heavy precipitation during the periods of attack and brood development seem to be most effective in drowning out the beetle and killing the young larvae.

The reasons for the greater susceptibility of trees during drought periods and the distribution of the broods with increased precipitation present an interesting problem for the plant physiologist.

If this theory is tenable it will involve the assumption that these southern pines, at any particular locality are closely adjusted to certain amounts of rainfall occurring in the local environment, even though the trees through out their native range do well in a very wide variety of conditions.

Seasonal History of the Southern Pine Beetle.

Throughout the Piedmont region and into eastern Virginia the seasonal history of the southern pine beetle is much the same. Certain variations in time of emergence occur with varying altitudes but need not be taken into consideration for the present purpose.

The first emergence of overwintering broods takes place about May 1st, about the time flowering dogwood is in full bloom, and from that time continues to increase until June. They immediately begin to infest green trees, the main attack occurring between May 15th and June 1st. The young larvae develop rapidly and some beetles from this generation emerge in both June and early July, but the second concentrated attack occurs between July 15th and August 15th. A third and partial fourth generation may occur but by this time there is so much overlapping of emergence that a continuous period of heavy attack takes place up until September 15th. A few trees are also infested during the latter part of September and in early October.

In the Gulf states the first emergence occurs about a month earlier and continues into November as many as six generations occurring.

Although the attack on green trees is somewhat continuous throughout the summer, the increase in the number of beetles causes a concentration during August and September in the northern regions (North Carolina through Virginia) and during July, August, September and October in the more southern portions of the range.

Illustrate diagramatically.

Maps - Range of beetle and southern pines

Discussion of Piedmont region.

Southern Pine Beetle Outbreaks.

The following is a discussion of the more important outbreaks and a presentation of the precipitation from the nearest Weather Bureau stations.

The Great West Virginia Epidemic of 1891-1892. The first general outbreak of which we have any authentic knowledge occurred in West Virginia in 1891 and 1892. Dr. Hopkins has described this in detail.[1] First reports of injury were received in March 1891

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1. Bul. 56, West Virginia Agricultural Experiment Station.

(which consequently indicates some trees attacked the preceding fall). During the summer of that year and through 1892 the epidemic progressively increased, killing great quantities of the yellow pines, also attacking spruce and white pine. Dr. Hopkins reports the epidemic in the following counties: Hampshire, Grant, Mercer, Webster, Summers, Pendleton, Greenbrier, Hardy, Pocohontas, Tucker, Randolph, Mineral, Raleigh, Doddridge, and Monongalia. Several counties in Virginia were also mentioned (Bath, Highland, Augusta and Rockingham) and reports of dying trees were received from adjacent counties of Maryland and Pennsylvania. Whether this outbreak extended further south in Virginia or into the Carolinas is not known, but from interviews with older residents in the Great Valley of Virginia it is likely this section was attacked as well.

During the year 1893 Dr. Hopkins again visited many points where his studies of the previous year had been conducted. He states that practically nowhere was he able to find any recently infested trees and many of those heavily attacked in the late summer of 1892 were still green and the broods did not develop. To quote from Dr. Hopkins (above citation),- "Upon felling and examining some of the trees that had died the previous fall and others that were then dying, I found upon removing the bark, that in every case all stages of the destructive barkbeetle were dead, and where there were a great many larvae in the bark, the odor from their decaying bodies was very perceptible." Again, summarizing his observations, he says - "I had found the destructive species dead in the trees in the northern part of the State, and here the same condition was found in the opposite or southern portion which indicated that possibly the species had been exterminated throughout the State." In the fall of 1893 a notice was sent to the principal timber owners containing the following: "It may be of interest to your readers to learn that the serious trouble, which in 1890-92 threatened the entire destruction of the valuable pine and black spruce forests in West Virginia and adjoining States is entirely over.****I am all the more convinced that this is so from the fact that I have not been able to find a single living example of the destructive pine bark beetle (Dendroctonus frontalis) in the State since the spring of 1893."

In looking for causes for the sudden decline of this epidemic Dr. Hopkins states - "In fact it is apparently the rule that, when an animal of almost any species increases to excessive abundance, it is, sooner or later, reduced to its normal position by its natural enemies, parasitic and predaceous insects, or unfavorable climatic conditions, or all combined." Under the discussion of climatic conditions Dr. Hopkins believes the severe low temperatures of the winter of 1892-93 caused the death of these beetles. This may have been in part responsible but the fact that the broods of the late summer attack did not develop in many places seems to disprove this theory.

At the time of this outbreak very few stations existed where rainfall was recorded. In fact no records are available from any of the localities where the infestation was reported as centering. Those stations in West Virginia where records are available show a general deficiency in rainfall for the years 1890, 91 and 92 as shown by the records for Harpers Ferry, Martinsburg, and Hinton, tables 1 and 2. These deficiencies likewise occurred through the summer during the period of brood development. Table 11 gives departures for the Great Valley of Virginia showing somewhat the same condition in these years. Here again few records are available and for the period under discussion, records for 1889 are from Lynchburg and Lexington, Va.; 1890, 91 and 92 are averages for Lexington, Lynchburg and Bedford City, Va.; 1893, 94 and 95 includes also Buchannan; 1896 to 1903 inclusive are for the three cities previously mentioned while the remainder of the table is for all stations in the valley existing for the years given. Such incomplete records,

quite distant from localities where the infestations are reported, are of course only suggestive and only indicative when considered in connection with the other comparisons given later.

It is altogether possible that the sudden decline of this epidemic may have been due to excessive precipitation in the late summer of 1892 as indicated by the history of later outbreaks.

Western North Carolina, 1902-05. The earliest report of an outbreak in this region was received in May 1902 near Tryon, Polk Co., N. C. Mr. W. F. Fiske inspected the trees and spent considerable time in this locality between 1902 and 1906, visiting surrounding points and from his records the following notes are taken.

In 1902 pines dying from the attack of the southern pine beetle were found near Fletcher, Henderson Co., as well as at Tryon. The following year infestations were noted on Pisgah Ridge between Haywood and Transylvania Cos. Beetles were present and apparently increasing at these points of observation until April 1906; also timber in the vicinity of Charlotte, Mecklenburg Co., was found infested. It is difficult to determine just when this outbreak died out, though from letters of April 1906 Mr. Fiske indicates that practically no living beetles could be found and later references during the summer confirm this view.

The nearest stations recording rainfall to these localities, where detailed observations were made, are Caroleen and Hendersonville. Monthly precipitation for Caroleen is given for the years 1903 to 1905 inclusive, table 3. Here in 1901 an annual excess of 22 inches is recorded; 1902 shows a deficiency of 4.53 inches with 5 of the 7 months between April and

October below normal. A deficiency of only .8 inches occurred in 1903, but the early part of this year was very wet while the summer, fall and winter were marked by a decided drought, extending almost continuously through the following year (1904), the latter with a total deficiency of 13.6. Again 1905 is below normal by 6.6 inches. This year, however, the months of deficiency and excess were well distributed though an excess of 3 inches occurred in July and August, the time of maximum attack of the second generation. During 1906 an excess of over 6 inches occurred well distributed through the summer season.

Hendersonville showed much the same character of rainfall as shown by the following: In 1901 an excess of 30.4; in 1902, 03 and 04, deficiencies of 11.4, 2.2, and 1.3, while in 1905 an excess of 7.0 occurred, chiefly during the months of May, June, July and August.

The records for Charlotte, table 4, are also very similar. They are as follows: In 1901 an excess of 13.6 inches; in 1902 a deficiency of 3.9; in 1903 a deficiency of 9.7; in 1904 a deficiency of 7.3; in 1905 a deficiency of 6.8, though in this year an excess of over 5 inches occurred during May, July and August; in 1906 an excess of .5.

Tenn.

This is one of the two epidemics (compare Unaka Nat. For.) which extended over a four year period and in both cases deficiencies in rainfall occurred over the same number of years.

Thomasville, Ga., 1904-1905. Mr. W. F. Fiske visited this vicinity in June 1906 and reports many dead trees showing the work of Dendroctonus frontalis. In a letter, June 4, 1906, he states - "Many trees were killed in 1905 by the early brood but none found from which hibernating or spring broods (of this year) emerged". The precipitation for Thomasville, Ga., is as follows; in 1903 an excess of 9.5; in 1904 a deficiency of 17.0 inches; in 1905 an excess of 5.3 inches occurring in May, June, August and September; 1906, an excess of 2.2 inches. The 1905 summer excess probably destroyed the summer generations.

Other Records of 1902-05. Several reports of dying pines were received from the states of Georgia, Alabama, Mississippi, Louisiana, and Texas from 1902 to 1905. In practically no cases did a representative of the Bureau make examinations or in cases where such were made report any extensive injury.

Green Bay, Va., 1906. Reports from this locality in 1906 indicated a serious local outbreak, but no confirmation of the conditions was made.

Virginia Beach, Va., 1907-08. During the summer of 1907 a rather severe though local outbreak of the southern pine beetle developed in the vicinity of Virginia Beach, Va. Control work was instigated in 1908 and by the following season the outbreak had completely disappeared.

Rainfall records for the nearest Weather Bureau station are given in table 5. Deficiencies occurred from September to December in 1906 and 1907 was a very dry year, practically 13 inches below the mean, with only one month (November) of normal rainfall. The following year (1908) shows a deficiency of nearly 6 inches but excesses are recorded for March, May and August.

Unaka National Forest, Tennessee and Virginia, 1913-16. First reports of this outbreak were received in February 1914 describing clumps of trees killed the previous summer on Iron Mountain. Dr. T. E.Snyder examined this area in the summer of 1914 and 1915 spending considerable time in studying the character and extent of the infestation. From his notes the following summary is taken. Trees dead at the time of the first examination indicated that the first trees were killed in late summer of 1912 or early in 1913. During the summer of 1914 over 2,000 trees (chiefly yellow pine) were infested in groups of various sizes and well scattered over the national forest and the surrounding privately owned land in an area about 20 miles x 10 miles. These groups occurred on top of ridges and south slopes, at elevations between 2,000 and 3,500 feet. A considerable part of the infested trees were treated in the early spring of 1915. Fall examinations revealed some 100 trees killed during the summer of 1915. In the fall of the following year no infested trees could be found.

One Weather Bureau station is located in near proximity of this infested area at Mountain City, Tenn. From records at this place, table 6, it can be seen that 1912 to 16 were all years of deficient rainfall. During 1914 and 1915 deficiencies of 8.8 and 15.2 inches, respectively, occurred and in each of these years only one month during the growing season shows an excess. The control work of 1915 was reported to be very effective and no doubt checked an

otherwise great increase later in that season, since even following control a number of trees were killed that summer. In 1916 when the infestation died out entirely three months of heavy precipitation occurred in July, August, and Septmmber, with an excess of about 5 inches during these months.

The South Carolina Epidemic of 1911. During the late summer of 1910 ~~the~~ reports were received calling attention to dying pines in South Carolina. By fall all indications pointed to a general outbreak of the southern pine beetle. The following spring a field station was located at Spartanburg, S. C., the apparent center of the outbreak, and many of the infestations throughout South Carolina, North Carolina and Georgia were examined. This outbreak was concentrated in the western portion of the State, bordering counties of North Carolina and in northern Georgia as indicated on the accompanying map. It developed into extensive proportions during the summer, destroying up to 50% of the finest timber in many localities. The counties where infestations were reported are as follows: Oconee, Pickens, Greenville, Anderson, Spartanburg, Cherokee, York, Newberry and Lexington, S. C.; Transylvania, Henderson, Polk, Rutherford, Cleveland, Gaston, Mecklenburg and Anson, N. C.; Habersham, Walker, Gordon, Chattooga, Fulton, and Newton, Ga.

Dr. Snyder's notes during the late summer of 1911 and spring of 1912 record detailed observations on the condition of the barkbeetle broods. It is clearly evident that this outbreak died out just as suddenly as that of 1892 in West Virginia. Many trees attacked by

the late summer broods of 1911 recovered while the attacking beetles were killed and the broods failed to develop. It was difficult to find living insects during the summer of 1912 and no further dying trees were observed.

Since the more detailed biological observations were made in the vicinity of Greenville and Spartanburg the rainfall records for these two points are given in tables 7 and 8. A deficiency in precipitation occurs during the fall and winter of 1909 - 10. The same occurred during the fall and winter of 1910-11, and through the early summer of 1911. After July a decided excess is shown, especially for Greenville, which continues through the winter and following spring. Although the deficiencies at these localities are not very marked, table 9 showing departures from the mean rainfall for the state of South Carolina indicates a general deficiency of rainfall for the state during 1909, 10 and 11. Tables 3 and 4 for Caroleen and Charlotte, N. C., show similar conditions for these years.

Eastern Texas 1911. Reports of dying pines were received from Houston, Polk and Montgomery Counties, Texas, during 1911 but no detailed studies were made of the conditions.

General Epidemic of 1922-23. For several years preceding 1921 practically no reports of the southern pine beetle were received from anywhere in the south. It was not until the fall of 1922 that it was realized that a rather general epidemic was developing. During the following year authentic evidence of the presence of this beetle was received

from practically every state from Virginia south to Texas. Although in very few states or counties did this epidemic assume anything like the proportions of the 1910-11 outbreak in South Carolina, yet it is no doubt the most general and widespread of all previous occurrences. The greatest injury perhaps occurred in Virginia, with local outbreaks in the eastern part of the state, and was particularly severe in the Valley of Virginia and the intervening mountains to the eastern borders of West Virginia. The accompanying map (fig.) indicates the counties from which the beetle was reported.

Very few localities were visited by entomologists so that little is known of the character of this outbreak except in a few places. These are as follows:

Laurel, Miss. Mr. R. A. St. George made an examination of the dying pine at this point in September 1923. He reports that at this time no living broods of the beetles could be found but that many trees had been killed the preceding year and in the spring of 1923. Table 10 gives the monthly departures from normal precipitation for the years 1921 to 1923 for Laurel, Miss. Both 1921 and 1922 show deficiencies of 6 and 7 inches respectively, occurring chiefly during the late summer and fall. In 1923 an excess of 20 inches is reported with very heavy rains during April, May and June, the period of brood development of the first generation.

The Great Valley of Virginia. First reports of dying pines were received in the fall of 1921, but it was not until the summer of 1923 that local outbreaks developed serious proportions. In the northern part of the valley outbreaks were scattered and extremely local but further south in the vicinity of Covington, Roanoke, Natural Bridge and the intermediate country few stands ~~under~~ over 30 years of age escaped. The outbreaks were uniformly on southerly exposures and high ridges, usually starting at higher elevations and working down. Throughout this region 25 to 40% of the pine, by volume, was destroyed, table-mountain and Virginia pine suffering most. The writer examined several infestations in the neighborhood of Harrisonburg, Va., Wardensville, W. Va., and the three towns previously mentioned during March and April 1924. It was (im)possible to find ~~scarcely any~~ but few living beetles particularly in the more southern localities. Great numbers of trees were attacked in August and September of 1923 but in all cases the beetles were drowned out after making their egg tunnels and the eggs either failed to hatch or the young larvae died soon after hatching.

Table 11 giving departures for the Valley of Virginia shows a general deficiency for this region in the years 1920, 21 and 22. In the vicinity of Covington the same drought conditions prevailed, table 12, until August, September, and October 1923 which months are characterized by an excess of over 5 inches, occurring during the time of maximum late summer attack and brood development.

Ashland, Va. In December 1922 Dr. T. E. Snyder examined a local outbreak in the vicinity of Ashland, Va. The owners reported that trees began dying in August of that year and later the timber died to such an extent that it was not possible to utilize it ~~ahead of the beetles~~ as fast as it died in a mill cutting 10,000 board feet per day. This stand was a mixture of loblolly and short leaf. Very few shortleaf were attacked, the beetles concentrating on the loblolly. An examination was made the following fall but no specimens of the beetles could be found. Control operations were conducted.

Table 13 gives the departures from normal precipitation for Ashland, Va., for 1920-22. 1921 shows a deficiency of over 10 inches while both 1920 and 1922 are years of excess.

Accomac, Va. During 1922 some loblolly pine was killed by the southern pine beetle on the eastern shore near Accomac, Va., and in the county south, Northampton, but it did not develop into serious proportions and the beetle had entirely disappeared the following year. Control operations were carried out by some owners.

The nearest Weather Bureau station is located at Onley, Va. The records (table 14) are very similar to those at Ashland.

These two cases are decided exceptions to all previous citations. One would have expected the outbreak to have started the previous summer and died out in 1922. It may be that some shortleaf pines were attacked in 1921 and acted as a nucleus for the breeding up of the

beetles that killed loblolly the following year. However, there may be something very significant in these two cases, showing similar weather conditions, the dry summer of 1921 and excessive precipitation of 1922, and confined only to loblolly. This latter tree is rarely attacked. That it might be a case of too much rain is hardly probable since loblolly is the best adapted of all the southern pines to moist or wet sites.

Tab 1.

Average Monthly and Annual Precipitation with Departures from Means for Harpers Ferry and Martinsburg, W. Va., from 1890 to 1893.

													Annual
1890	.50	3.09	2.87	1.40	4.56	2.15	2.32	5.54	3.97	5.35	.69	3.16	36.60
	-	+	-	-	+	-	-	+	+	+	-	+	
Dept.	2.17	.63	.26	.70	.93	1.94	1.41	1.70	1.16	2.57	1.51	.49	-.07
1891	2.01	2.09	5.52	1.64	2.38	3.40	5.08	3.48	.38	1.85	1.97	2.33	31.83
	-	-	+	-	-	-	+	-	-	-	-	-	
Dept.	.66	.37	2.39	1.46	1.25	.69	1.35	.36	2.33	.93	.23	.34	-4.84
1892	3.85	1.33	5.15	2.89	2.74	4.53	2.69	1.70	2.37	.10	2.78	2.04	31.70
	+	-	+	-	-	-	-	-	-	-	+	-	
Dept.	1.18	1.13	2.42	.21	.89	.45	1.04	2.14	.44	2.68	.58	.63	-5.43
1893	1.66	2.42	.97	4.18	4.89	2.06	4.39	3.43	2.49	4.85	2.43	.59	34.38
	-	-	-	+	-	-	+	-	-	+	+	-	
Dept.	1.01	.04	2.16	1.08	1.26	2.03	.66	.41	.32	2.07	.23	2.08	-2.29
Means	2.67	2.46	3.13	3.10	3.63	4.09	3.73	3.84	2.81	2.78	2.20	2.67	37.13

Tab 2

Monthly and Annual Precipitation with Departures from Means for Hinton, Summers County, W. Va., for 1890 - 93.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1890	--	--	--	3.78	4.40	4.00	3.47	3.49	2.17	4.06	0.84	3.29	---
				+	+	-	-	-	-	+	-	+	
Dept.	--	--	--	.50	.63	.23	.48	.37	.59	1.50	1.36	.49	---
1891	2.36	6.38	6.18	2.39	5.01	3.15	2.47	4.62	0.48	1.53	2.09	2.51	39.17
	-	+	+	+	+	-	-	+	-	-	-	-	
Dept.	.85	3.33	2.13	.11	1.24	1.08	1.48	.76	2.28	1.03	.11	.29	- .55
1892	3.02	2.23	3.71	5.77	3.36	2.64	3.17	2.74	1.32	0.21	3.95	2.32	34.44
	-	-	-	+	-	-	-	-	-	-	+	-	
Dept.	.19	.82	.88	2.59	.41	1.59	.78	1.12	1.44	2.35	1.75	.48	-5.28
1893	1.67	5.52	1.64	4.35	5.56	7.02	2.30	3.32	4.50	5.17	1.20	1.04	43.49
	-	-	-	+	+	+	-	-	+	+	-	-	
Dept.	1.34	2.47	2.41	1.07	1.79	2.79	1.65	.54	1.74	2.61	1.00	1.76	+3.77
Means	3.21	3.05	4.05	3.28	3.77	4.23	3.95	3.86	2.76	2.56	2.20	2.80	39.72

Tab 3

Monthly and Annual Precipitation for Carolean, N. C., from 1900 to 1923.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	An'al.	Dept.
1900	3.09	10.69	5.29	6.77	2.92	6.99	2.79	1.45	1.05	4.15	5.27	5.10	55.56	
1901	2.65	2.21	5.10	8.45	9.00	10.62	4.86	14.20	7.21	1.18	0.95	8.94	75.37	
1902	1.97	8.19	5.45	1.80	3.22	5.25	2.90	2.23	5.93	3.34	3.20	4.45	47.93	
1903	5.45	10.04	9.19	4.10	1.14	10.90	0.21	3.53	2.02	1.10	2.44	1.41	51.52	
1904	2.08	3.75	3.80	1.13	3.00	4.84	4.00	7.74	0.82	0.07	4.10	3.51	38.84	
1905	3.49	6.13	1.13	2.29	4.89	1.36	6.79	7.30	2.05	2.08	0.73	8.56	46.80	
1906	8.52	0.47	6.22	2.35	1.87	5.81	7.43	12.64	6.04	2.80	0.85	4.15	59.15	
1907	0.05	2.34	2.40	2.93	5.19	9.48	2.90	5.22	6.74	1.02	5.81	7.22	51.30	
1908	5.20	8.02	4.10	4.21	2.79	4.39	10.14	13.51	1.78	6.93	2.17	5.34	66.58	
1909	3.33	4.52	5.38	5.67	4.32	9.30	4.85	5.50	6.52	1.81	0.28	4.26	55.74	
1910	3.33	4.94	1.12	1.46	5.82	6.36	3.19	11.09	2.23	4.24	0.24	4.04	48.06	
1911	2.89	2.11	3.09	5.43	0.39	1.17	2.73	6.02	4.80	6.37	3.33	7.06	45.39	
1912	2.47	5.40	9.10	5.08	3.17	6.97	4.01	2.75	3.91	2.15	3.67	2.39	51.07	
1913	5.75	3.75	7.40	1.52	5.06	5.29	3.56	2.54	5.23	4.57	1.52	5.56	51.75	
1914	2.25	3.96	2.59	4.41	0.69	6.01	2.76	3.23	2.84	5.78	4.61	11.66	50.79	
1915	7.16	4.82	4.30	0.40	4.32	5.25	2.95	6.25	3.70	5.03	2.85	6.04	53.07	
1916	2.60	4.71	1.52	2.55	4.17	7.35	19.40	3.88	2.41	2.40	0.97	2.68	54.64	
1917	2.98	5.15	8.57	4.13	2.56	2.25	---	5.57	6.31	1.65	.37	1.44	---	
1918	7.04	2.43	--	--	--	4.92	8.56	2.82	5.27	10.96	3.21	4.49	---	
1919	6.16	4.40	5.71	2.58	5.45	6.77	9.41	2.42	.64	3.35	2.53	3.88	53.30	+.37
1920	4.63	3.36	8.14	7.00	2.33	4.84	4.79	11.87	6.15	.32	6.19	5.75	65.37	+12.8
1921	6.20	5.51	1.83	2.74	4.32	4.67	3.98	3.70	6.14	4.40	4.00	1.75	49.24	
1922	5.34	6.52	6.58	6.65	4.56	4.58	4.58	3.39	1.80	4.25	.91	5.25	54.41	
1923	4.78	3.64	8.38	5.08	4.72	2.43	5.08	3.41	4.81	1.37	4.83	3.88		
Means	3.92	4.90	4.81	3.01	3.68	5.16	5.44	5.74	3.88	3.55	2.46	5.11	52.46	

Table 4.

Monthly Precipitation for Charlotte, N. C., from 1900 to 1923.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1900	2.15 −	5.25 −	5.28 −	5.32 +	2.11 +	7.31 +	3.55 +	3.05 +	0.73 +	3.41 −	3.85 −	4.33 +	46.34
1901	2.38 −	1.96 +	5.48 −	7.25 −	8.00 −	6.47 −	6.38 −	10.66 −	6.43 +	1.04 +	0.98 +	5.79 −	62.82 +
1902	2.42 −	6.07 +	3.54 +	1.68 −	3.39 −	4.07 +	4.58 −	3.74 −	3.48 +	4.49 −	4.44 −	3.42 −	45.32 −
1903	3.10 −	6.02 −	5.77 −	3.28 −	0.53 −	5.35 +	1.89 +	4.55 +	3.29 −	2.53 −	1.43 +	1.75 −	39.49 −
1904	1.38 −	3.42 +	2.60 −	0.89 −	2.15 +	6.43 −	6.20 +	10.32 +	1.78 −	0.91 −	3.01 −	2.86 +	41.93 −
1905	2.11 +	5.38 −	0.95 +	2.72 −	6.08 −	0.58 +	5.77 +	8.67 +	2.34 −	0.70 +	0.57 −	6.56 −	42.44 −
1906	6.34	1.63	5.17	0.93	3.66	4.83	5.57	8.56	2.40	4.17	1.07	3.31	47.66 −
1907	0.51	3.24	2.09	2.57	4.07	4.19	5.30	1.84	3.75	0.81	4.61	6.99	39.98
1908	6.18	3.75	4.27	1.29	2.20	2.65	5.62	14.61	1.50	6.58	1.69	4.06	54.00
1909	1.64	3.64	2.86	3.99	5.65	7.04	2.70	5.16	2.06	1.37	0.44	2.51	39.06
1910	3.36	3.59	0.86	2.34	4.26	8.14	3.12	4.82	2.89	4.01	0.36	2.53	40.28 −
1911	1.93	1.93	2.77	2.66	1.23	2.02	2.86	6.20	4.76	3.51	3.36	4.64	37.87 −
1912	2.81	5.00	7.86	3.92	3.14	5.39	3.56	1.87	3.50	1.14	1.90	1.34	41.43 −
1913	3.70	2.52	5.80	2.72	3.77	4.21	4.42	4.48	2.45	2.29	3.22	4.57	44.15
1914	2.78	4.03	1.56	2.99	0.49	2.12	4.83	2.25	2.02	3.11	2.45	6.53	35.16
1915	5.67	2.89	3.44	0.63	5.47	5.45	3.08	4.59	2.37	2.97	1.96	3.53	42.05
1916	1.66	5.87	1.38	2.15	4.41	5.55	16.55	2.70	0.88	2.64	0.36	2.32	46.47
1917	3.08	3.78	6.42	2.54	2.54	4.70	5.85	4.84	3.29	1.95	0.75	1.69	41.43
1918	3.82	1.92	2.33	5.47	2.92	2.43	1.90	2.18	5.83	3.00	3.23	4.35	39.38
1919	5.45	4.85	2.70	3.90	6.38	2.43	7.40	3.94	0.81	4.46	1.02	2.20	45.54
1920	3.81	3.51	7.11	5.40	1.33	3.56	4.11	8.91	3.53	0.10	4.95	4.47	50.79
1921	5.22	4.61	1.84	1.99	4.50	1.35	5.55	2.78	2.55	1.76	4.02	2.66	38.81
1922	5.24	7.12	6.32	6.59	3.72	2.74	5.19	2.74	1.23	5.32	.92	4.47	51.60
1923	3.67	4.35	5.84	4.23	4.01	2.21	5.89	2.93	2.32	1.13	3.09	3.33	42.90
Means	4.29	4.39	4.57	3.44	3.92	4.46	5.49	5.55	3.22	3.15	2.86	3.86	49.20

Table 5

Monthly and Annual Precipitation for Cape Henry, Va., from 1905 to 1923.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	
Means	3.03	3.28	3.63	3.06	3.72	3.89	5.12	4.68	2.81	3.06	1.99	3.13	41.40	
1905	2.95	3.86	2.14	3.58	2.84	2.05	6.63	4.51	3.51	1.85	0.62	3.57	38.11	
1906	2.03	4.04	3.40	1.29	2.05	1.80	9.19	15.85	0.55	2.80	0.47	3.12	46.59	
1907	0.72	3.18	2.36	2.56	2.64	3.48	2.31	2.71	1.32	0.82	3.34	3.00	28.44	
1908	2.31	2.19	4.36	2.06	4.64	3.02	3.52	6.01	2.42	1.60	0.93	2.73	35.79	
1909	1.73	2.56	1.20	3.11	3.86	6.26	3.93	3.91	0.78	1.03	0.49	1.76	30.62	
1910	2.62	2.25	2.93	1.59	3.04	4.07	5.08	3.87	0.69	2.96	0.97	3.62	33.69	
1911	3.15	1.84	3.58	2.48	0.62	4.43	1.90	3.19	0.65	1.70	2.90	3.14	29.58	
1912	2.52	1.95	3.42	2.13	1.86	3.09	1.22	2.43	2.80	0.62	1.72	5.19	28.95	
1913	3.35	1.63	2.70	1.06	3.90	5.17	9.51	3.94	2.27	2.19	1.01	1.45	38.18	
1914	2.05	2.32	2.85	1.67	1.48	3.76	2.71	1.16	2.75	2.06	2.44	3.70	28.95	
1915	4.39	1.29	1.02	0.93	3.30	3.14	2.57	1.21	0.46	2.73	0.83	1.35	23.22	
1916	1.92	2.54	1.54	1.29	4.17	3.03	4.31	3.08	1.50	2.20	0.79	2.60	28.97	
1917	2.27	1.85	4.08	2.07	2.09	5.68	8.67	2.47	3.74	3.07	0.63	2.78	39.40	
1918	3.47	0.36	3.74	3.51	2.59	5.42	4.56	2.87	4.43	0.67	1.12	3.40	36.14	
1919	3.70	2.47	4.05	2.09	3.65	2.48	6.58	4.18	1.08	1.68	0.08	2.50	34.54	
1920	2.29	7.92	3.76	5.16	1.00	5.29	6.31	5.83	2.98	1.58	2.93	4.36	49.41	
1921	1.30	3.25	2.50	3.39	3.47	3.59	8.28	3.69	2.74	1.59	1.67	4.16	39.63	-10.26
1922	4.24	4.62	6.29	1.67	1.83	8.74	11.83	6.06	2.30	2.75	.73	3.94	55.09	+5.20
1923	2.51	2.08	6.55	5.85	1.13	1.42	3.64	3.13	4.15	1.81	2.03	2.05	36.35	

Table 6

Monthly and Annual Precipitation at Mountain City, Tennessee, from 1900 to 1918.[1]

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	An'al.	Dept.
1900	− 1.38	− 4.54	+ 5.50	− 1.98	− 3.37	+ 5.57	+ 7.17	− 4.70	+ 5.14	+ 4.32	+ 3.82	− 2.56	50.05	+
1901	+ 4.10	− 1.61	− 4.18	+ 6.51	+ 8.17	+ 8.14	− 4.45	+ 16.34	2.02	3.30	0.89	8.36	68.27	+
1902	3.12	5.50	4.47	2.64	2.99	10.08	1.95	6.35	4.67	2.50	3.20	2.91	50.38	+
1903	3.09	7.21	5.79	4.95	1.21	5.29	5.12	3.96	0.98	1.76	3.86	2.75	45.97	−
1904	− 3.04	− 2.93	+ 4.98	− 3.02	− 3.72	− 3.72	− 3.81	+ 4.46	− 1.44	− 0.13	+ 3.53	+ 4.46	39.24	−
1905	4.21	5.66	2.54	3.80	7.19	3.60	10.09	4.62	1.44	2.89	1.07	4.60	51.71	+
1906	7.93	1.20	3.96	3.54	3.76	4.41	7.28	6.92	4.26	4.08	3.03	4.45	54.82	+
1907	1.60	3.39	3.49	3.85	3.78	7.75	7.01	6.65	7.36	2.48	4.70	4.04	56.10	+
1908	----	----	3.58	5.24	4.30	6.43	6.90	3.34	1.32	5.09	1.90	6.18	-----	
1909	3.04	4.22	4.63	3.64	3.48	6.92	5.17	2.57	3.63	3.59	0.81	1.66	43.36	−
1910	4.12	2.90	0.47	3.00	4.51	5.22	8.93	3.74	2.37	2.42	2.17	2.75	42.60	−
1911	4.65	2.64	6.73	6.25	1.71	4.62	5.68	4.60	2.48	4.40	2.71	3.67	50.14	+
1912	− 2.73	− 2.33	+ 5.29	+ 5.16	+ 5.22	− 2.23	− 5.62	− 4.01	+ 3.94	− 1.33	− 1.59	− 1.97	41.42	−
1913	− 3.40	− 2.51	+ 7.10	− 2.77	+ 6.18	− 2.98	− 3.70	− 4.71	− 3.79	− 1.47	− 1.64	+ 2.28	42.53	−
1914	− 2.00	+ 3.52	+ 5.19	− 2.56	− 1.82	− 1.84	+ 6.62	− 4.68	− 1.23	− 1.47	− 1.85	+ 5.57	38.35	−
1915	− 3.34	− 2.46	− 1.10	− 2.34	− 3.91	− 2.07	− 3.09	− 5.18	+ 3.70	− .95	− 1.55	+ 4.47	34.16	− 15.20
1916	+ 4.30	− 3.08	− 3.92	− 1.19	− 2.49	− 2.13	+ 8.45	+ 7.46	+ 3.47	− 2.25	− 1.85	− 2.00	42.19	− 4.99
1917	4.34	--	--	--	--	--	7.82	2.63	2.39	2.77	.82	2.55	--	
1918	6.68	1.93	4.10	4.44	3.93	5.80	4.82	4.46	3.16	6.13	1.94	2.37	49.76	+ 2.58
Means	3.74	3.44	4.51	3.64	4.03	4.76	5.82	5.21	3.13	2.71	2.14	3.76	47.18	

1. Records for 1919 to 1923 very incomplete.

Table 7.

Precipitation

Monthly and Annual ~~Departures from the Mean~~ for Greenville, S. C., from 1909 to 1912.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	
	-	-	+	-	+	+	+	+	+	-	-	-		
1909	3.07	4.99	6.14	1.43	8.89	10.35	7.86	5.09	4.95	2.29	1.30	4.60	60.96	+
	-	-	-	-	+	+	-	-	-	-	-	-		
1910	3.10	4.07	5.20	1.56	12.81	6.69	3.73	3.76	3.79	2.95	0.30	4.56	49.52	-
	-	-	-	+	-	-	+	+	-	+	+	+		
1911	3.19	3.08	3.62	5.07	1.82	2.90	6.56	5.71	2.74	5.71	4.41	7.34	52.25	+
	+	+	+	+	+	+	-	-	+	-	+	-		
1912	3.91	6.39	10.29	8.17	7.14	6.58	4.89	2.65	4.30	3.03	3.62	3.16	64.13	
Means	3.43	5.25	5.39	3.65	3.56	5.09	5.73	5.06	3.79	3.20	3.10	4.71	51.96	

Table 8

Monthly and Annual Precipitation for Spartanburg, S. C., from 1900 to 1923.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual.
1900	2.74	8.19	5.34	5.94	3.17	7.94	2.03	1.72	2.11	3.56	5.45	4.45	52.64
1901	3.06	2.80	7.19	7.29	9.47	6.56	3.49	15.66	5.81	1.01	0.96	10.23	73.53
1902	3.06	7.88	5.02	1.28	1.81	6.43	3.61	1.20	5.85	4.36	3.33	4.68	48.51
1903	5.04	9.03	8.68	4.43	1.59	9.96	2.17	4.64	2.25	1.05	1.82	1.82	52.48
1904	1.37	3.03	5.00	1.52	2.07	4.78	4.04	11.79	1.47	0.83	3.99	4.10	43.99
1905	2.78	5.81	1.01	2.82	7.21	1.01	6.76	7.19	0.80	2.10	1.16	8.07	46.72
1906	8.69	1.00	6.32	1.34	3.03	4.91	7.97	12.45	5.97	3.07	0.94	3.84	59.53
1907	0.38	2.89	1.21	3.72	4.12	8.28	3.39	4.08	6.83	1.15	6.44	8.21	50.70
1908	6.67	5.82	4.87	2.65	3.74	4.20	9.61	12.79	1.90	5.48	1.51	4.99	64.23
1909	2.53	5.11	4.18	2.12	7.13	11.24	4.22	4.47	5.69	1.79	1.25	3.23	52.96
1910	3.67	2.83	3.54	1.43	6.89	9.45	3.69	6.46	2.56	4.24	0.20	3.67	48.63
1911	2.01	2.32	3.41	5.09	0.87	2.06	1.91	2.81	2.48	4.64	4.28	5.20	37.08
1912	3.87	5.93	10.11	5.03	3.80	6.64	2.96	1.82	2.94	2.74	4.00	2.69	52.53
1913	4.68	4.07	6.57	1.97	2.64	4.03	6.96	2.21	5.29	3.60	1.10	5.65	48.77
1914	2.62	3.72	1.52	3.42	0.65	2.61	2.27	4.92	1.54	4.71	4.44	10.69	43.11
1915	6.22	3.81	3.09	1.18	4.40	4.18	1.98	8.55	0.86	5.86	2.75	5.33	48.21
1916	1.62	5.28	1.75	2.72	4.71	4.29	15.48	1.25	2.63	2.56	1.17	2.90	46.36
1917	3.59	4.36	9.03	3.87	2.96	2.62	2.82	2.51	4.70	2.19	0.43	1.15	40.23
1918	6.27	2.64	2.80	3.46	1.95	3.44	4.50	2.00	4.43	8.39	3.29	5.63	48.80
1919	6.93	5.84	3.39	1.92	9.68	5.39	12.15	4.21	1.85	2.51	3.71	4.98	62.56
1920	4.63	3.84	7.21	7.34	2.72	3.62	6.80	8.92	4.19	0.14	4.99	6.24	60.64
1921	5.47	6.89	2.20	2.54	4.67	2.59	3.40	4.50	4.10	3.67	3.43	2.31	45.77
1922	5.22	8.25	6.07	7.35	5.35	3.58	4.84	1.33	1.77	3.17	.57	5.59	53.09
1923	3.96	4.57	7.56	4.98	4.99	.79	7.17	6.55	1.11	1.19	4.83	4.05	51.75
Means	3.81	4.58	4.88	3.08	4.09	4.68	4.69	5.59	3.28	2.81	2.83	4.24	48.56

Table 9

Monthly and Annual Departures from the Mean for South Carolina from 1909 to 1912

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	-	-	+	-	+	+	-	-	-	-	-	-	
1909	1.79	.13	.90	.20	1.13	2.0	.85	1.40	.16	.52	1.40	.77	- 3.19
	-	+	-	-	+	+	+	-	-	+	-	-	
1910	.39	.19	2.48	1.53	.33	2.52	.09	.31	.72	1.22	1.36	1.27	- 3.71
	-	-	-	+	-	-	-	-	-	+	+	+	
1911	1.73	2.89	1.55	.13	2.87	1.64	1.90	.50	.63	2.75	1.03	1.58	- 8.22
	+	+	+	+	+	+	-	-	+	-	+	-	
1912	1.61	1.50	2.99	1.42	.56	.62	.47	2.86	1.95	.93	.44	.48	+ 6.30

Table 10

Monthly and Annual Departures from the Means Precipitation for Laurel, Mississippi, from 1921 to 1923[1].

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	An'al.
1921	-.67	-.83	+6.12	+6.70	-2.87	-3.44	-4.61	+1.04	-1.12	-1.86	-2.00	-2.47	- 6.01
1922	-.63	+.72	+2.67	-1.19	+.28	+1.54	-.93	-2.64	-3.05	-1.77	-1.77	-.24	- 7.01
1923	-2.38	+.66	-.53	+2.75	+9.29	+3.51	-1.39	+.75	-1.11	+1.96	+3.48	+3.23	+20.12
Means	5.67	5.35	5.60	5.28	4.49	4.41	7.13	4.69	4.19	2.37	3.53	6.36	59.07

1. Values for Sep., Oct.,and Nov. 1921, Jun., Jul., Aug., and Sep., 1922, and Jan., 1923 are based on the average of two nearest stations, Hattiesburg and Shubuta, Miss.

Table 11

Precipitation in the Great Valley of Virginia showing Departures from Normal.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Av.
1889	+ 2.0	- .2	- 1.	- .2	+ 1.6	- .5	+ 5.6	- .4	+ 4.4	+ 1.6	+ 3.5	- 2.8	+ 15.6
1890	- 1.8	+ 1.3	- .3	- 1.1	+ .6	- 1.2	- .5	- 1.1	- .1	+ 1.5	- 2.0	+ .9	- 3.4
1891	+ 1.3	+ 1.7	+ 3.9	+ .1	+ 2.	- 2.1	+ 1.2	+ 1.9	- 1.8	- 2.9	+ .5	+ .6	+ 6.2
1892	+ 1.6	- .1.	- .3	+ 1.2	- 1.	- .7	- .4	- 2.2	- .3	- 3.1	+ 1.6	- 1.5	- 5.2
1893	- 1.5	+ 1.5	- 2.3	- .1	+ 2.1	- .9	- 1.4	+ 3.9	+ 2.8	+ 2.5	- .8	- 1.8	+ 4.5
1894	- 1.2	+ .8	- 1.8	- 1.3	+ .2	- 2.2	- .9	- 1.3	+ .03	+ .4	- 1.2	- .4	- 9.7
1895	+ 3.1	- 1.7	- .5	+ 1.2	- .1	- 1.	- .2	- 2.2	- 2.6	- 2.1	- .1	+ .04	- 6.7
1896	- .8	+ 1.	+ 1.7	- 1.5	- .8	+ .2	+ 3.6	- 2.1	+ 3.2	- 2.5	+ 2.8	- 2.7	+ 4.4
1897	- 1.3	+ 4.2	- .2	- 1.2	+ .6	- 1.1	- .1	- 2.4	- 1.3	- .2	+ .02	+ .3	- 3.5
1898	- .8	- 1.4	+ .1	- .03	+ 4.	- .9	+ 1.1	+ .3	+ .7	+ 4.7	- .1	+ .7	+ 7.2
1899	+ 1.	+ 2.4	+ 4.4	- 1.1	+ .4	+ .4	- .1	+ 2.6	+ .9	- .6	- 1.2	- 1.5	+ 6.5
1900	+ .7	+ 1.6	- .2	+ .5	- .4	+ 2.5	- 1.3	- 2.4	+ 1.3	- .1	- .1	+ .04	+ 2.1
1901	- .1	- 2.5	+ .3	+ 2.9	+ 1.4	+ .5	+ .5	+ 6.3	- .2	- 2.8	- 1.	+ 5.2	+ 12.5
1902	+ .4	+ 2.4	- .1	- .8	- 1.4	- .5	- 2.	- 1.9	- .8	+ 3.3	+ 1.5	+ .1	+ 1.9
1903	+ 1.6	+ 2.2	+ 2.1	+ .2	- 2.5	+ 2.3	- 2.	+ .2	+ .04	- 1.	- .7	- 1.7	+ 1.1
1904	- .7	- 1.8	- .9	- .1	- .7	+ 1.8	- .4	- 1.2	- 1.8	- 2.1	- .4	+ .5	- 9.4
1905	- .3	- .2	- 1.2	- .8	+ 1.1	- .4	+ 2.6	- .2	- .9	+ .5	- 1.4	+ 1.5	- .2

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Av.
1906	+ 1.4	- 2.6	+ .2	- .4	- 1.4	+ 1.	+ 1.	+ 3.6	+ .5	+ 3.2	+ .5	+ .4	+ 7.3
1907	- 1.1	- 1.1	- .6	+ .8	- 1.1	+ 2.6	- .4	- .6	+ 3.3	- 1.5	+ 2.4	+ .4	+ 3.1
1908	+ .5	+ .1	- .5	+ .3	+ .8	- .7	+ .2	+ 1.	- .8	+ 2.	- 1.	+ .7	+ 2.8
1909	- .4	- .1	- .3	+ .4	+ .8	+ .9	- 1.	- 1.7	- .4	- .2	- 1.6	- 1.	- 4.8
1910	+ .6	- .9	- 3.1	+ 1.1	- .4	+ 2.1	+ .8	- 1.3	- 1.	- .9	- 1.2	- .8	- 5.
1911	+ 1.7	- 1.1	+ .3	+ 1.2	- 2.6	- 1.1	- .2	+ 1.3	- .8	+ 2.2	+ .4	+ .6	+ 1.5
1912	- 1.	- .7	+ 2.6	+ 1.	+ .5	- 1.2	- .2	- 1.7	+ 1.9	- 1.5	- .4	- .3	- .9
1913	+ .3	- 1.	+ 1.9	- .3	+ 1.4	- 1.1	- .8	- .2	- .2	+ .8	+ .2	- .6	+ .8
1914	+ .1	- .3	- .7	- .8	- 2.4	- 1.9	- .4	- 1.4	- 1.7	- .1	+ .1	+ 2.2	- 6.7
1915	+ 1.4	- .2	- 2.4	- 1.9	- .4	- 1.2	+ .9	+ 1.4	+ .8	+ .9	- 1.2	+ .9	- 1.
1916	- .4	+ .2	- 1.5	- .8	- 1.3	+ .8	+ 1.8	+ .3	- .3	- .6	- .9	- .9	- 3.6
1917	+ .3	- .4	+ 3.	- .1	- 1.2	- 2.3	+ .1	- 1.7	- 1.1	+ .1	- 2.	- 1.6	- 6.6
1918	+ 1.9	- 2.	- .2	+ 1.7	- .5	+ 1.1	- .2	+ .6	+ .1	+ 1.6	- .9	+ .6	+ 3.9
1919	+ .7	- 1.	- .9	- .4	+ 1.3	+ 1.	0	- 1.	- 2.	+ 1.2	- .1	- .3	- 1.4
1920	- .5	- .4	- .4	+ .3	- 1.8	+ .3	+ .2	+ 2.3	- .5	- 2.7	+ 2.3	- .5	- 1.3
1921	- .2	- .4	- 2.1	- 1.	- .2	- 1.4	- 2	- 1.2	- .1	- .6	+ .9	- 1.1	- 7.7
1922	- .2	+ .7	+ .9	- .9	+ .6	- .3	+ .7	- 1.2	- 2.1	- .2	- 1.7	+ 1.	- 2.1
1923	+ .4	+ .03	+ .1	- .6	- 1.5	- .2	- .2	- .4	+ .2	- 1.7	+ .3	- .3	- 2.9
Means	3.22	3.23	3.51	2.94	3.58	4.30	4.23	3.96	3.35	3.26	2.38	3.15	41.12

Table 12

Monthly and Annual Departures of Precipitation for Stations* Surrounding Covington, Va., from 1920 to 1923.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	-	+	-	+	-	+	-	+	-	-	+	-	-
1920	1.05	.34	.65	.14	1.37	.18	.64	2.70	1.02	3.31	2.82	.31	2.17
	+	-	-	-	-	-	+	-	-	+	+	-	-
1921	.19	.67	1.82	1.08	.71	.94	.34	1.95	.44	.24	.82	1.24	7.10
	+	+	+	-	+	+	+	-	-	-	-	+	-
1922	.38	1.14	2.12	.53	1.11	.03	.17	.94	2.08	1.26	1.97	.77	.04
	-	-	+	-	-	-	-	+	+	-	-	-	-
1923	.16	.48	.77	.07	1.64	1.62	.55	2.22	.56	1.65	.67	.52	2.43
Means 1924	2.50	2.95	3.62	2.97	3.44	4.51	4.01	4.02	3.39	3.39	2.34	3.01	41.57

* Catawaba Sanitorium, Buchanan, Roanoke, and Lexington.

Table 13

Monthly departures from the mean precipitation for Ashland, Va., for 1920-22.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1920	- .30	+ 3.84	- .60	- .22	- 1.49	+ 2.77	+ 1.37	+ 7.48	+ .05	- 2.42	+ 4.60	- .87	+14.21
1921	+ .59	- .07	- 1.31	+ .25	+ .07	- 2.05	- 1.32	- 3.80	- 2.16	- 1.61	+ * .58	+ * .02	-10.81
1922	+ * 1.56	+ * .71	+ * 3.29	- 1.76	+ .13	+ .06	+ 1.57	+ 1.64	- 1.55	+ .15	- 1.85	+ 1.14	+ 5.09
Means	2.88	2.90	3.50	3.60	4.04	4.17	4.77	4.49	3.18	3.25	2.32	2.92	42.00

* Records for Richmond, Va.

Table 14

Monthly precipitation for Onley, Va., for 1920 - 22

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1920	2.45	6.90	5.72	3.18	0.50	5.15	6.79	-	-	0.90	5.92	3.22	40.73*
1921	1.82	4.05	1.95	5.65	4.10	0.90	2.82	3.80	0.55	2.80	3.12	2.49	34.05
1922	4.15	5.70	6.15	2.65	2.33	5.48	9.37	7.90	2.50	2.70	0.70	5.64	55.27

* for ten months.